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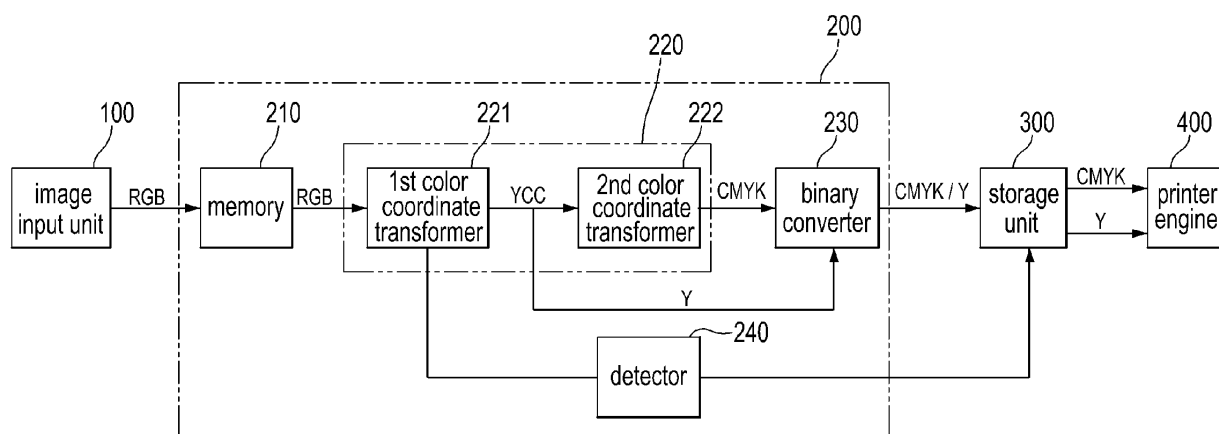
A request for re-establishment of rights in respect of the twelve-month period from the date of filing of the first application has been granted (Art.87(1) and Art. 122 EPC).

(54) **Image forming apparatus and control method**

(57) An image forming apparatus and a method of controlling the same in which input image data is divided into blocks and colour chrominance data of each block

is analyzed thereby perform a print job by automatically detecting whether an image should be print in colour or pure black.

FIG. 2



Description

[0001] The present invention relates to an image forming apparatus and a method for controlling the same, which analyze image data to automatically and discriminately detect whether the image should be printed in colour or with pure black.

[0002] Image forming apparatuses, such as a digital multi-function printer (DMFP) and a copy machine, may obtain an image through a scanning operation of a sensor or receive the image from an external device, such as a host computer. In addition, in the image forming apparatuses, the obtained image is subject to colour-coordinate transformation so that the image may be printed by a printer engine.

[0003] FIG. 1 shows an example image forming apparatus. Such an image forming apparatus includes an image input unit 10, an image processing unit 20, a storage unit 30, and a printer engine 40. Referring to FIG. 1, an image input unit 10 provides red, green, and blue (RGB) data of a document image to an image processing unit 20. Here, as an example, the image input unit 10 obtains a scanned image using an image sensor, such as, a charge coupled device (CCD) or a contact image sensor (CIS).

[0004] The image processing unit 20 includes a memory 21 to store the RGB data of the document image, a colour coordinate transformer 22 to transform the RGB data received from the memory 21 into cyan, magenta, yellow, and black (CMYK) data for printing, and a binary converter 23 to convert the CMYK data into binary CMYK data. The binary CMYK data on a printable medium converted by the image processing unit 20 is provided to a printer engine 40 through a storage unit 30. The printer engine 40, having received the CMYK data, prints the CMYK data so as to reproduce the image.

[0005] When the image processing unit 20 performs the colour coordinate transformation, a portion of a black-and-white image may be erroneously converted into a colour image due to characteristics of sensors used for obtaining an image. In such case, a printed result may have colour components different from those of an original image. For this reason, when black letters are printed, colour components may exist thereby degrading readability of the printed result. When a user inputs a colour printing command, even though an image includes only black letters, the image forming apparatus uses a composite black colour in order to print the image on a printable medium. However, the composite black deteriorates the readability of the printed result as compared to a pure black colour.

[0006] When an image forming apparatus equipped with an auto-document feed (ADF) function duplicates colour documents together with black-and-white documents, the user must manually set the colour types of the documents to be duplicated thereby causing inconvenience to the user. For this reason, a method of performing printing operations by automatically detecting

the type of the documents is necessary.

[0007] Japanese Unexamined Patent Publication No. 9-277606 discloses a colour printer which prints input colour data using only black colour when RGB components of the input colour data have the same value. However, according to this conventional method, if a black-and-white document has a colour stain, such as, a thin line drawn by a red pen, the black-and-white document cannot be completely reproduced. Accordingly, RGB component must be inspected with respect to all pixels in the image data of the document.

[0008] Accordingly, aspects of the present invention have been made to address the above-mentioned and/or other problems, and aspects of the present invention provide an image forming apparatus and a method for controlling the same, which analyze image data so as to perform printing work by automatically and discriminately detecting and determining whether the image data should be printed in colour or pure black.

[0009] According to an aspect of the present invention, there is provided an image forming apparatus including a printer engine to receive colour data and to print a document, an image input unit to input image data of the document, and an image processing unit to perform colour coordinate transformation with respect to the image data of the document, and to determine a type of the document based on a colour chrominance signal of the transformed image data.

[0010] According to another aspect of the present invention, there is provided a method for controlling an image forming apparatus having a printer engine to receive colour data to print a document, comprising inputting image data of the document, colour-coordinate transforming the image data of the document, determining a type of the document based on a colour chrominance signal of the transformed image data, and printing the document using the printer engine according to the type of the document.

[0011] According to another aspect of the present invention, a method of controlling an image forming apparatus is provided, comprising colour-coordinate transforming image data of the document; determining a type of the document to be one of a colour document, a black-and-white document, and a mixed document based on a colour chrominance signal of the transformed image data; and printing the document using the printer engine according to the type of the document.

[0012] According to another aspect of the present invention, an image forming apparatus is provided, comprising an image input unit to convert a document into image data; an image processing unit to convert the image data into luminance and colour chrominance data and print colour data, the image processing unit comprising: a first colour coordinate transformer to convert the image data into the luminance and colour chrominance data, a second colour coordinate transformer to convert the luminance and colour chrominance data into print colour data, a binary converter to the luminance data

received from the first colour coordinate transformer and the print colour data received from the second colour coordinate transformer into binary data, a detector to determine whether the document is a colour document, black-and-white document, or a mixed document according to analysis the colour chrominance data received from the first colour coordinate transformer, a storage unit to store the luminance and colour chrominance data and the print colour data; and a printer engine to print the document according to whether the document is a colour document, black-and-white document, or a mixed document.

[0013] Additional aspects and/or advantages of the invention will be set forth in part in the description which follows and, in part, will be obvious from the description, or may be learned by practice of the invention.

[0014] These and/or other aspects and advantages of the invention will become apparent and more readily appreciated from the following description of the embodiments, taken in conjunction with the accompanying drawings of which:

FIG. 1 is a block diagram of a conventional image forming apparatus;

FIG. 2 is a block diagram of an image forming apparatus according to aspects of the present invention;

FIG. 3 is a illustrates the dividing of the scanned document image data into blocks according to aspects of the present invention;

FIG. 4 is a view showing a predetermined block including 64096 pixels according to aspects of the present invention;

FIGs. 5 and 6 are graphs showing the determination of the type of the document based on a block according to aspects of the present invention, in which FIG. 5 shows first colour chrominance signals for 64096 pixels in a block and FIG. 6 shows second colour chrominance signals for 64096 pixels in a block;

FIG. 7 is a view showing a document image including a black-and-white image and a colour image according to aspects of the present invention;

FIGs. 8A to 8D are views showing relationships between blocks according to aspects of the present invention, in which FIG. 8A shows the relationship between two blocks adjacent to each other in a horizontal direction, FIG. 8B shows the relationship between three blocks adjacent to each other in a horizontal direction,

FIG. 8C shows the relationship between two blocks adjacent to each other in a vertical direction, and FIG. 8D shows the relationship between three blocks adjacent to each other in a vertical direction according to aspects of the present invention; and

FIG. 9 is a flowchart showing the operational control of an image forming apparatus according to aspects of the present invention.

[0015] Reference will now be made in detail to the present embodiments of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to the like elements throughout. The embodiments are described below in order to explain the present invention by referring to the figures.

[0016] FIG. 2 is a block diagram showing the structure of processing an image obtained through a scanner in an image forming apparatus according to aspects of the present invention. The image forming apparatus 200 includes an image input unit 100, an image processing unit 200, a storage unit 300, and a printer engine 400. Referring to FIG. 2, an image input unit 100 provides RGB data of the image to an image processing unit 200. The image input unit 100 may obtain a scanned image using a charge coupled device (CCD) or a contact image sensor (CIS). Further, the input image unit 100 may provide the RGB data of the image to the image processing unit 200 from an electronic image sent to the image forming apparatus 200 via a wired or wireless network; from a handheld device, such as a camera, a personal digital assistant, a digital media player; or from a personal computer, a laptop computer, or a server.

[0017] The image processing unit 200 includes a memory 210 to store the RGB data of the image, a colour coordinate transformer 220 to transform the RGB data obtained from the memory 210 into CMYK data for printing, a binary converter 230 to convert the CMYK data into binary data, and a detector 240 to determine whether the image is to be reproduced as a black-and-white document or a colour document. If the image is to be reproduced as a black-and-white document, only pure black is used to print the reproduction. However, if the image is to be reproduced in colour, multiple colours are used to print the reproduction. Further, the image may be determined to be reproduced in black-and-white (or with pure black) for one area of the image and reproduced in colour for another area of the image.

[0018] The colour coordinate transformer 220 includes a first colour coordinate transformer 221 and a second coordinate transformer 222 in order to obtain the CMYK data from the RGB data. The first colour coordinate transformer 211 transforms the RGB data into luminance and colour chrominance (YCC) data, and the second colour coordinate transformer 222 transforms the YCC data into CMYK data.

[0019] The detector 240 receives the YCC signals from the first colour coordinate transformer 221 and divides the YCC signals into $M \times N$ blocks as shown in FIG. 3. In this case, each block of the $M \times N$ block (e.g., a first block B00 positioned at 1st column j and 1st row K) includes 64096 pixels P_x arranged in a square as shown in FIG. 4. As such, the YCC signals from the first colour coordinate transformer 221 may be divided by the detector into as many $M \times N$ blocks as necessary. Further, it is understood that each block of the $M \times N$ block may be divided into any number of blocks BKj, K and j need not be equal,

and the blocks BK_j may include any number of pixels P_x, which need not be arranged in a square.

[0020] Referring again to FIG. 2, the detector 240 receives a luminance signal (Y) and two colour chrominance signals (Cr and Cb) for each pixel P_x from the first colour coordinate transformer 221, and calculates average values of each of the colour chrominance signals (C_{rs} and C_{bs}) for each block BK_j. Referring to FIG. 5, the colour chrominance signals (C_{rs}) for 64096 pixels P_x corresponding to pixel numbers 0 to 63 in each block fluctuate about the average value (GA) thereof. In addition, referring to FIG. 6, the colour chrominance signals (C_{bs}) for 64096 pixels corresponding to pixel numbers 0 to 63 in each block are fluctuate about the average value (GB) thereof.

[0021] If the colour chrominance signals for the 64096 pixels P_x in one of the blocks BK_j are within the preset range (T1 and T2) including the respective average values (GA and GB) of the colour chrominance signals (C_{rs} and C_{bs}), the detector 240 determines that the corresponding block BK_j represents reproduction as a black-and-white document. If the intensities of the colour chrominance signals for the 64 pixels P_x are not within the preset ranges (T1 and T2), the detector 240 determines that the block BK_j represents reproduction as a colour document. As the colour chrominance signals (C_{rs} and C_{bs}) fluctuate about the averages (GA and GB) within the preset ranges (T1 and T2) in FIGs. 5 and 6, the image would be determined to be reproduced as a black-and-white document. However, aspects of the present invention are not limited thereto such that if the colour chrominance signals (C_{rs} and C_{bs}) fluctuated about the averages (GA and GB) within the preset ranges (T1 and T2), the image could be determined to be reproduced as a colour document. Further, as described below with regard to FIG. 7, the colour chrominance signals may indicate that areas of adjacent blocks are all in colour while another area of adjacent blocks are in black-and-white such that the former area would be printed in colour and the latter area would be printed in black-and-white.

[0022] The detector 240 may calculate average values (GA and GB) of the colour chrominance signals (C_{rs} and C_{bs}) with respect to several blocks BK_j of an original image and may determine the type of the original image based on the average values. If all of the blocks BK_j represent reproduction as a black-and-white document (i.e., the intensities of the colour chrominance signals (C_{rs} and C_{bs}) are within the preset ranges (T1 and T2)), the detector 240 determines the original image is to be reproduced as a black-and-white document. If it is determined that a number of blocks BK_j represent reproduction as a colour document (i.e., the intensities of the colour chrominance signals (C_{rs} and C_{bs}) are not within the preset ranges (T1 and T2)) compared to a number of all of the blocks BK_j is not greater than the preset number of blocks BK_j, the relationship between the blocks is analyzed as described below. Although described as determining the type of reproduction of an image based on both the colour

chrominance signals (C_{rs} and C_{bs}), it is understood that the type of document may be determined according to one of the colour chrominance signals (C_{rs} and C_{bs}).

[0023] As shown in FIG. 7, a document A includes a first area A1 containing a black-and-white image and a second area A2 containing a colour image, and each area may be divided into the M×N blocks which include the blocks BK_j. If a block BK_j representing reproduction as a colour document exists, the detector 240 determines based on the relationship between the block BK_j and neighboring blocks (such as BK_(j+1) or B_(K-1)) whether the document is to be reproduced as a black-and-white document having only the first area A1 or the document is to be reproduced as a colour document having the second area A2. Furthermore, the detector 240 may determine that the image is a mixed image having both the first area A1 and the second area A2, in which case the image is to be reproduced such that the second area A2 is reproduced in colour and the first area A1 is reproduced in pure black.

[0024] The relationship between blocks can be represented as a determination of degree of colour for an image, and the relationship between neighboring blocks may be variously represented. Four typical cases will be described below according to aspects of the present invention. In other words, FIG. 8A shows the relationship between two blocks adjacent to each other in a horizontal direction, FIG. 8B shows the relationship between three blocks adjacent to each other in a horizontal direction, FIG. 8C shows the relationship between two blocks adjacent to each other in a vertical direction, and FIG. 8D shows the relationship between three blocks adjacent to each other in a vertical direction. Specifically in FIG. 8A, block B11 is horizontally adjacent to block B12, and block B12 is recognized as representing colour reproduction. In FIG. 8B, block B31 is immediately and horizontally adjacent to block B32, and block 32 is immediately and horizontally adjacent to block B33, which is recognized as representing colour reproduction. In FIG. 8C, block B21 is vertically adjacent to B22, which is recognized as representing colour reproduction. In FIG. 8D, block B41 is immediately and vertically adjacent to block B42, and block B42 is immediately and vertically adjacent to block B43, which is recognized as representing colour reproduction. It is understood that blocks BK_j may be adjacent without being immediately adjacent and that blocks BK_j may be other than horizontally and vertically adjacent.

[0025] The detector 240 may determine that the input image is to be reproduced as a colour document based on the relationships between the blocks BK_j. In detail, the type input image (i.e., colour or black-and-white) may be determined according to the number of blocks in which colour reproduction is represented. In other words, if the number of blocks in which colour is present is greater than the predetermined number, the detector 240 determines that the image is to be reproduced as a colour document. If the number of the blocks in which colour is present is not greater than the predetermined number,

the detector 240 determines that the image is to be reproduced as a black-and-white document. Such determination allows for determining whether the image should be reproduced in colour or pure black even if a portion of the document has a trivial colour contamination.

[0026] However, it is understood that the image forming apparatus is not limited to only the determination between colour and black-and-white and may also determine the degree of colour present in an image and use the degree of colour to reproduce the image. For example, the detector 240 may determine that the document A of FIG. 7 includes a first area A1 containing a black-and-white image and a second area A2 containing a colour image. As such, the first area A1 may be printed as if the whole of document A was a black-and-white document, and the second area A2 may be printed as if the whole of document A was a colour document.

[0027] Referring back to FIG. 2, the detector 240 provides a detection signal to the binary converter 230 in order to discriminate whether the input image is to be reproduced as in colour or pure black according to the determination result as described above. The binary converter 230 converts luminance data (Y) received from the first colour coordinate transformer 221 into binary data by receiving the luminance data (Y) from the first colour coordinate transformer 221 and then provides 1-channel binary data to the storage unit 300. In addition, the binary converter 230 that converts CMYK data into binary data by receiving the CMYK data from the second colour coordinate transformer 222 and provides 4-channel binary data to the storage unit 300.

[0028] The storage unit 300 individually stores the 1-channel binary data for the luminance data and the 4-channel binary data for the CMYK data, and provides the 1-channel binary data or the 4-channel binary data to the printer engine 400 according to the detection signal received from the detector 240.

[0029] If the printer engine 400 receives the 1-channel binary data, the printer engine 400 performs a printing operation by using a pure-black colour so as to improve the readability of a resultant black-and-white document. If the printer engine 400 receives the CMYK data, the printer engine 400 performs a typical printing operation so as to reproduce the colour input image as a colour document.

[0030] However, it should be understood that the detection signal provided to the binary converter 230 from the detector 240 may discriminate between portions of colour and portions of black and white such that the first area A1 of the document A of FIG. 7 would be printed using the pure-black colour via the 1-channel binary data received by the printer engine 400 from the storage unit 300 while the second area A2 of the document A of FIG. 7 would be printed using colour via the 4-channel binary data for the CMYK data received by the printer engine 400 from the storage unit 300. As such, the black-and-white portion of the document (i.e., the first area A1) is

printed so as to improve the readability of the black-and-white portion while the colour portion is reproduced with appropriate colour.

[0031] Hereinafter, a method for controlling the image forming apparatus according to aspects of the present invention will be described with reference to FIG. 9. Input image data of an image is obtained through the image input unit 100 and then provided to the image processing unit 200 (operation 500). The image processing unit 200 transforms the colour-coordinate data of the input image data into CMYK data and YCC data for printing. According to an aspect of the current invention, the first colour coordinate transformer 221 transforms the RGB data of the input image data into luminance and colour chrominance (YCC) data, and the second colour coordinate transformer 222 transforms the luminance and colour chrominance (YCC) data into the CMYK data (operation 502).

[0032] The detector 240 receives the YCC data from the first colour coordinate transformer 221 and divides the YCC data into $M \times N$ blocks (operation 504). Then, in operation 506, the detector 240 calculates average values of chrominance signals with respect to plural blocks of the input image data so as to determine the type of or the degree of colour of the input image data based on the average values. If the all blocks represent reproduction as a black-and-white document, the input image is reproduced as a black-and-white document. If a number of the blocks in which colour is present is not greater than a predetermined number, the relationship between the blocks is analyzed so as to determine sizes of portions in which colour is present or in which only black is present. As such, the entire document may not be printed in colour although an errant colour mark may be present on a small portion of the document. Then, the type of document or the degree of colour of the document is determined according to the analyzing result (operation 506).

[0033] The detector 240 determines whether the input image is to be reproduced as a black-and-white document (operation 508). If the input image is to be reproduced as a black-and-white document, a detection signal corresponding to the black-and-white input image is applied to the storage unit 300 so that the printer engine 400 prints the black-and-white document by using a pure black colour (operation 510). If the input image is determined to be reproduced as a colour document, a detection signal corresponding to the colour input image is applied to the storage unit 300, so that the printer engine 400 typically prints the colour document using plural colours (operation 512). In another aspect, the detector 240 determines that portions of the input image are black-and-white while other portions of the input image are colour so that the detector 240 applies a detection signal containing information as to which areas of the input image are to be printed with pure black and which areas of the document are to be printed with plural colours.

[0034] As described above, according to aspects of the present invention, input image data are divided into

blocks, and colour chrominance data of the blocks is analyzed with respect to each block to thereby exactly determine whether the input image is to be reproduced as a colour document or a black-and-white document.

[0035] According to aspects of the present invention, since the method of reproduction of the input image is determined based on the relationship between blocks, erroneous determination caused by colour contamination can be prevented. In addition, according to aspects of the present invention, even if a user unsuitably sets a colour duplication command for a black-and-white document, the black-and-white document can be printed by using a pure black colour, so that the readability of the document can be improved as compared with that of the document printed using a composite black colour. Further, the detector can provide information regarding areas of the input image containing colour and areas of the input image containing only black and white so that different areas of the image can be reproduced using plural colours and black, respectively.

[0036] Although a few embodiments of the present invention have been shown and described, it would be appreciated by those skilled in the art that changes may be made in this embodiment without departing from the principles of the invention, the scope of which is defined in the claims.

Claims

1. An image forming apparatus, comprising:

an image input unit through which image data is input to the image forming apparatus; and
an image processing unit for performing colour coordinate transformation of the input image data to thereby produce transformed image data and for determining a printing operation according to a colour chrominance signal of the transformed image data.

2. The image forming apparatus of claim 1, further comprising a printer engine coupled to receive the transformed image data and print an image on a printable medium according to the received transformed image data.

3. The image forming apparatus of claim 1 or 2, wherein the image processing unit comprises:

a first colour coordinate transformer to transform the input image data into luminance and colour chrominance data of the document; and
a detector to analyze colour chrominance data of the luminance and colour chrominance data to determine the printing operation.

4. The image forming apparatus of claim 3, wherein the

image processing unit further comprises a second colour coordinate transformer to transform the luminance and colour chrominance data into colour data.

5. The image forming apparatus of claim 3 or 4, wherein the detector is arranged to divide the colour chrominance data into blocks, and the detector is further arranged to divide the colour chrominance data in each block into pixels.

6. The image forming apparatus of claim 5, wherein the detector is arranged to determine the printing operation to be a black-and-white operation if the colour chrominance data for all of the pixels in each block is within a preset range based on an average value of the colour chrominance data for all pixels in each block.

7. The image forming apparatus of claim 5 or 6, wherein the detector is arranged to determine the printing operation to be a colour operation if a number of blocks in which the colour chrominance data for all of the pixels in each block is outside of a preset range based on average values of the colour chrominance data for all pixels in each block, is greater than a predetermined number.

8. The image forming apparatus of claim 7, wherein the detector is arranged to determine the printing operation by analyzing relationships between blocks if the number of the blocks in which the colour chrominance data for all of the pixels in each block is outside of the preset range is equal to or less than the predetermined number.

9. The image forming apparatus of claim 8, wherein the detector is arranged to determine areas of the document as a having number of blocks consecutively representing the same printing operation.

10. The image forming apparatus of claim 9, wherein the detector is arranged to analyze the blocks in a horizontal direction or in a vertical direction.

11. The image forming apparatus of any one of claims 3 to 10, wherein the luminance and colour chrominance data comprises a first colour chrominance and a second colour chrominance, and the detector is arranged to individually analyze the first colour chrominance and the second colour chrominance.

12. The image forming apparatus of any one of claims 5 to 10, wherein the blocks comprise pixels arranged in a square.

13. The image forming apparatus of claim 4, wherein the transformed image data comprises:

the colour data received from the second colour coordinate transformer; and
 luminance data of the luminance and colour chrominance data received from the first colour coordinate transformer, and
 the image processing unit further comprises a binary converter to convert the transformed image data into binary data.

14. The image forming apparatus of claim 13, further comprising a storage unit to individually store binary data of the colour data as four-channel binary data and binary data of the luminance data as one-channel binary data, the four-channel binary data and the one-channel binary data being received from the binary converter.
15. The image forming apparatus of claim 14, further comprising a printer engine coupled to receive the transformed image data and print an image on a printable medium according to the received transformed image data, wherein the storage unit selectively provides the four-channel binary data and the one-channel binary data to the printer engine according to the determination of the printing operation by the detector.
16. The image forming apparatus of claim 15, wherein the four-channel binary data is provided to the printer engine when the detector determines that the printing operation is a colour printing operation, and the one-channel binary data is provided to the printer engine when the detector determines that the printing operation is a black-and-white printing operation.
17. A method of controlling an image forming apparatus having a printer engine to receive transformed image data to print a document, the method comprising:
- inputting image data of an image;
 - colour-coordinate transforming the image data of the image;
 - determining a printing operation according to a colour chrominance signal of the transformed image data; and
 - printing the document using the printer engine according to the determined printing operation.
18. The method of claim 17, wherein the colour-coordinate transforming comprises:
- transforming the input image data of the document into luminance and colour chrominance data; and
 - transforming the luminance and colour chrominance data into colour data.

19. The method as claimed in claim 17 or 18, wherein

the determining the printing operation comprises:

- dividing the colour chrominance data into blocks;
- calculating an average value of the colour chrominance data of each block; and
- determining the printing operation to be a black-and-white printing operation if the colour chrominance data of all pixels of each block is within a preset range based on an average value of the colour chrominance data of all of the pixels in the each block.

20. The method of claim 19, wherein the determining the printing operation further comprises:

- determining whether a number of blocks in which the colour chrominance data of all pixels in the block are out of the preset range about the average value is greater than a predetermined number; and
- determining the printing operation to be a colour printing operation if the number of blocks is greater than the predetermined number.

21. The method of claim 20, wherein the determining the printing operation further comprises:

- determining the printing operation according to an analysis of relationships between the blocks if the number of the blocks is not greater than the predetermined number.

22. The method of claim 21, further comprising:

- determining the printing operation as a mixed printing operation if the relationships between the blocks indicates that a first area of adjacent blocks have a first similar colour chrominance data and a second area of adjacent blocks have a second similar colour chrominance data;
- printing the first area in colour; and
- printing the second area in pure black.

23. A method of controlling an image forming apparatus, comprising:

- colour-coordinate transforming input image data of an image; determining a printing operation to be one of a colour printing operation, a black-and-white printing operation, and a mixed printing operation according to a colour chrominance signal of the transformed image data; and
- printing the transformed image data using the printer engine according to the determined printing operation.

24. The method of claim 23, wherein, if the printing op-

eration is determined to be a mixed printing operation, the printing comprises:

printing a first area of the document in colour;
and
printing a second area of the document in pure black.

25. An image forming apparatus, comprising:

an image input unit through which image data of an image is input to the image forming apparatus;
an image processing unit to convert the input image data into luminance and colour chrominance data and colour data, the image processing unit comprising:
a first colour coordinate transformer to convert the input image data into the luminance and colour chrominance data,
a second colour coordinate transformer to convert the luminance and colour chrominance data into colour data,
a binary converter to convert the luminance data received from the first colour coordinate transformer and the print colour data received from the second colour coordinate transformer into binary data,
a detector to determine a printing operation according to whether the image is a colour image, black-and-white image, or a mixed image according to analysis of the colour chrominance data received from the first colour coordinate transformer,
a storage unit to store the luminance and colour chrominance data and the colour data; and
a printer engine to print the image according to the determined printing operation.

26. The image forming apparatus of claim 25, wherein the determined printing operation is a colour printing operation when the image is a colour image, and the determined printing operation is a pure black printing operation when the image is a black-and-white image.

FIG. 1

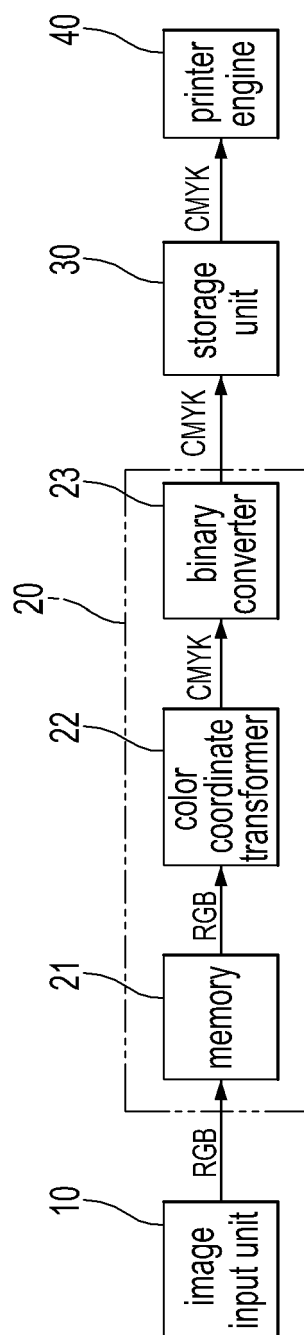


FIG. 2

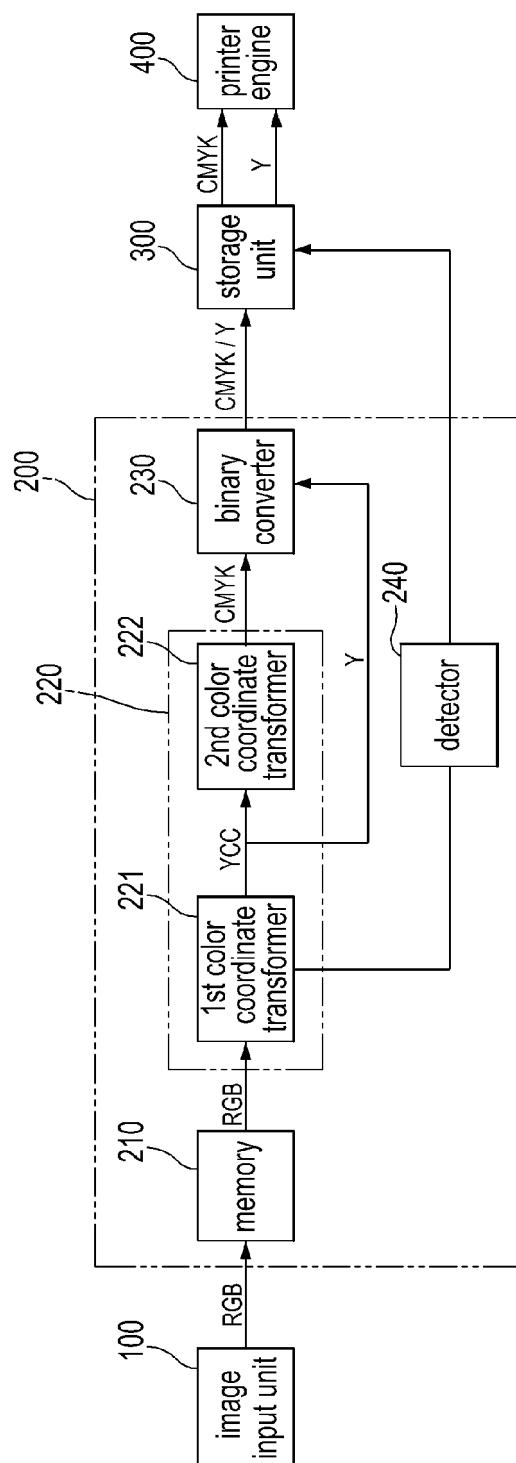


FIG. 3

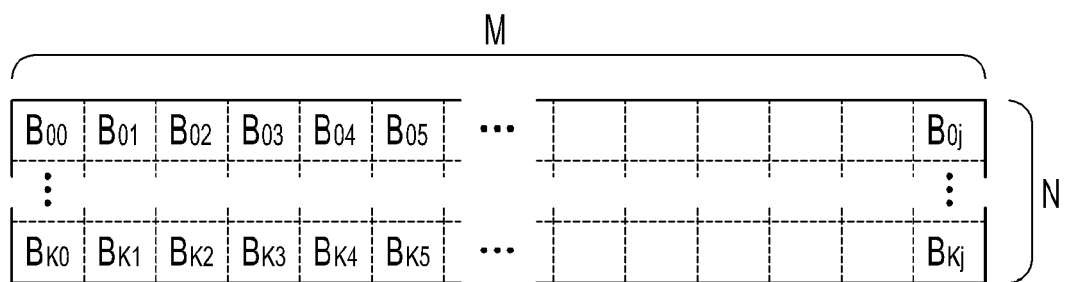


FIG. 4

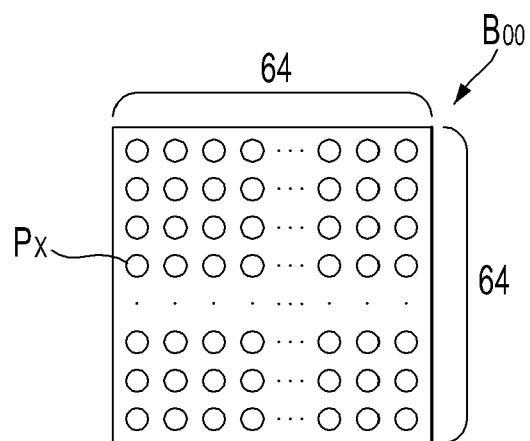


FIG. 5

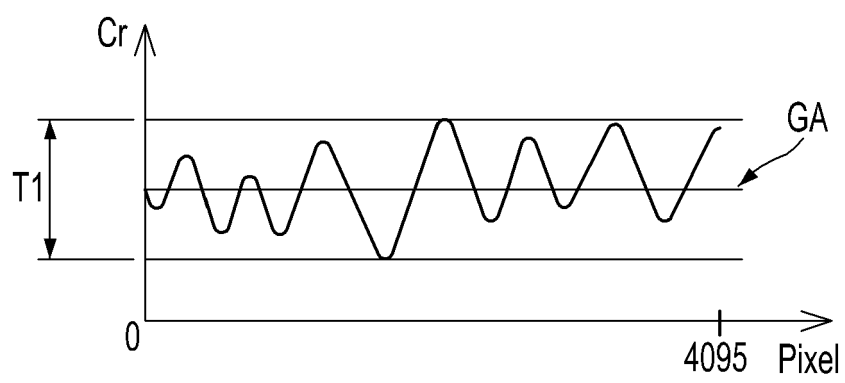


FIG. 6

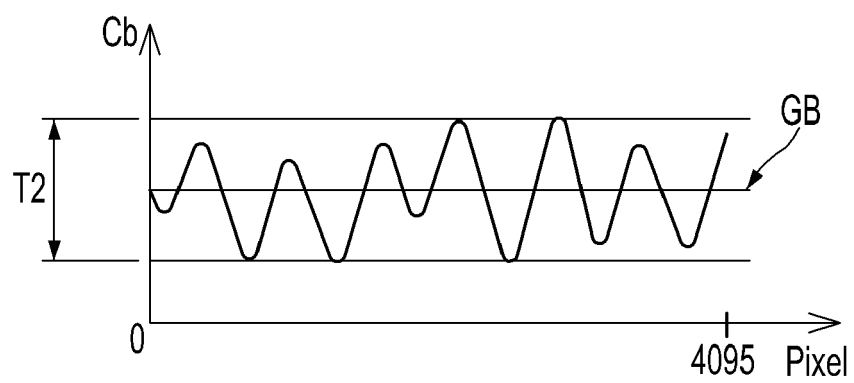


FIG. 7

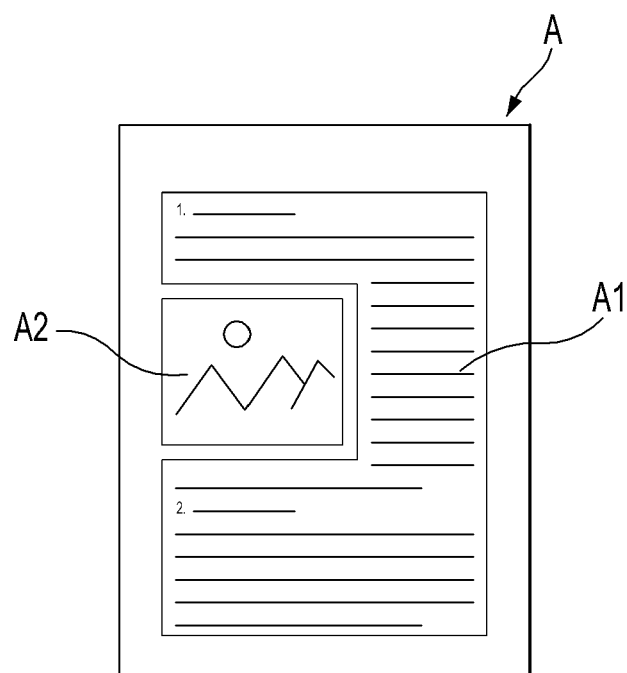


FIG. 8A

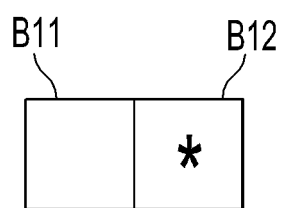


FIG. 8B

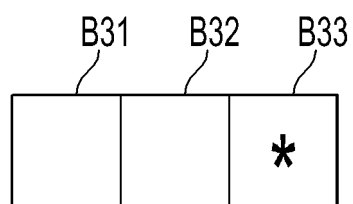


FIG. 8C

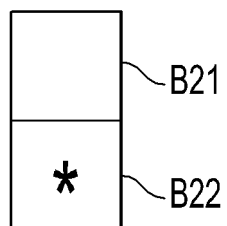


FIG. 8D

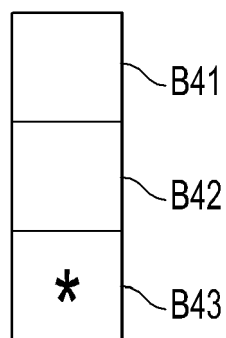
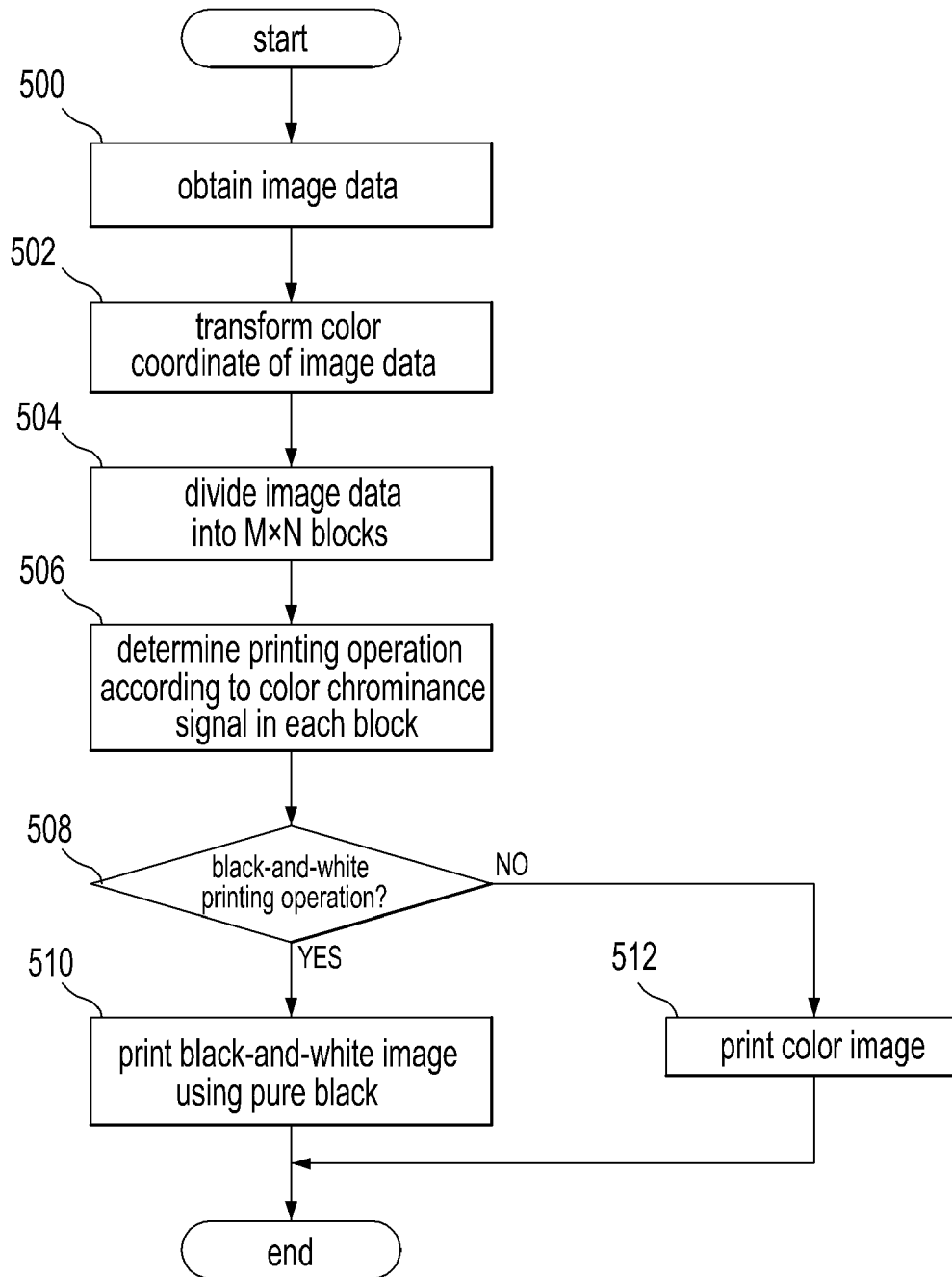


FIG. 9



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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